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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/812,591	03/29/2004	Pooran Chandra Joshi	SLA0786	2314
27518	7590	05/10/2006	EXAMINER	
SHARP LABORATORIES OF AMERICA, INC 5750 NW PACIFIC RIM BLVD CAMAS, WA 98642			SARKAR, ASOK K	
			ART UNIT	PAPER NUMBER
			2891	

DATE MAILED: 05/10/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/812,591

Applicant(s)

JOSHI ET AL.

Examiner

Asok K. Sarkar

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 06 April 2006.
2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-38 is/are pending in the application.
4a) Of the above claim(s) _____ is/are withdrawn from consideration.
5) ☒ Claim(s) 34 is/are allowed.
6) ☒ Claim(s) 1-33 and 35-38 is/are rejected.
7) ☐ Claim(s) _____ is/are objected to.
8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 1 – 6, 9, 18, 32 and 33 are rejected under 35 U.S.C. 102(e) as being anticipated by Belyansky, US 2004/0129673.

Regarding claim 1, Belyansky teaches a method for forming silicon dioxide (SiO₂) on a silicon carbide (SiC) substrate, the method comprising:

- providing a SiC substrate;
- supplying an atmosphere including He and oxygen (paragraph 29);
- performing a high - density (HD) plasma – based process; and,
- forming a SiO₂ layer overlying the SiC substrate in paragraphs 12 – 21.

Regarding claim 2, Belyansky teaches connecting a top electrode (RF coils in Fig. 1) to an inductively coupled HD plasma source in paragraph 30.

Regarding claim 3, Belyansky teaches the plasma – based process includes performing an HD plasma oxidation process in response to the HD oxidation process, creating a reactive oxygen species, breaking the Si – C bonds in the SiC substrate, to

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form free Si and C atoms in the SiC substrate and wherein forming a SiO₂ layer overlying the SiC substrate includes bonding the free Si atoms in the SiC substrate to the HD plasma – generated reactive oxygen species, and growing the SiO₂ layer in paragraphs 19 and 29 – 30.

Regarding claim 4, Belyansky teaches substrate temperature of 360 °C and less in paragraph 31.

Regarding claims 5 and 6, Belyansky teaches supplying an atmosphere including oxygen includes supplying O₂ with an inert gas such as Kr and Ar, where the ratio of inert gas to O₂ is in the range between 10:1 and 200:1 in paragraph 18.

Regarding claim 9, Belyansky teaches forming a SiO₂ layer overlying the SiC substrate includes forming a SiO₂ layer at deposition rate of about 100 Å in 10 minutes in paragraphs 19 and 29.

Regarding claims 32 and 33, Belyansky teaches a method for growing silicon dioxide (SiO₂) on a silicon carbide (SiC) substrate, the method comprising:

- providing a SiC substrate at a temperature of 360 degrees C, or less;
- supplying an atmosphere including oxygen;
- performing a high – density (HD) plasma oxidation process;
- in response to the HD oxidation process, creating a reactive oxygen species;
- breaking the Si – C bonds in the SiC substrate, to form free Si and C atoms in the SiC substrate;
- bonding free C atoms in the SiC substrate with the reactive oxygen species, forming carbon monoxide (CO); and,

- bonding the free Si atoms in the SiC substrate to the HD plasma – generated reactive oxygen species, and growing the SiO₂ layer in paragraphs 18, 19 and 30.

The breaking of the the Si – C bonds in the SiC substrate, to form free Si and C atoms in the SiC substrate and bonding free C atoms in the Sic substrate with the reactive oxygen species, forming carbon monoxide (CO) is inherent in Belyansky's process when SiC is used for oxidation.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

5. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein

were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

6. Claims 7, 8, 19 – 23 and 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Belyansky, US 2004/0129673.

Regarding claim 7, Belyansky teaches evacuating the plasma reaction chamber and maintaining a low reactor pressure, but fails to teach removing the CO that is formed by reaction of the oxygen and free C atoms in the chamber.

However, it would have been obvious to one with ordinary skill in the art at the time of the invention that the during the pumping of the reactor chamber the generated CO and the other gases present inside will be evacuated during the process of plasma oxidation. The deposition chamber is connected to an evacuation system.

Regarding claim 8, Belyansky teaches maintaining a reactor pressure and the dilution ratios of the oxygen with the inert gases and locating the SiC between the top and bottom electrode and applying power density with respect to Fig. 1 and in paragraphs 29 – 31, but fails to teach total gas flow of ~ 50 – 200 sccm and supplying a power density of up to 10 watts per square centimeter (W/cm^2), at a frequency in the range of 13.56 to 300 megahertz (MHz), to the top electrode; and, supplying a power density of up to 3 W/cm^2 , at a frequency in the range of 40 kilohertz (KHz) to 13.56 MHz, to the bottom electrode.

However, it would have been obvious to one with ordinary skill in the art at the time of the invention to judiciously adjust and control these parameters during the plasma oxidation process through routine experimentation and optimization to achieve optimum benefits for the deposited film (see MPEP 2144.05) without undue experimentation as taught by Belyansky in paragraph 32 and it would not yield any unexpected results.

Note that the specification contains no disclosure of either the critical nature of the claimed processes or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen methods or upon another variable recited in a claim, the Applicant must show that the chosen methods or variables are critical (*Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir., 1990)). See also *In re Aller, Lacey and Hall* (10 USPQ 233 – 237).

Regarding claims 19, 20 and 38, Belyansky teaches that SiO₂ can be formed by HD plasma oxidation of any Si containing material in paragraph 19 but fails to teach depositing a Si layer over the SiC substrate.

However, since the oxide is formed by the reaction between the Si atom and oxygen, it would have been obvious to one with ordinary skill in the art at the time of the invention that the SiO₂ can be formed by oxidizing a thin Si layer deposited on the SiC substrate and it can be either crystalline or amorphous Si material.

Regarding claims 21 – 23, Belyansky teaches the limitations of these claims as have been explained earlier in rejecting claims 4 – 6 and 8.

Regarding claim 37, Belyansky teaches most limitations as was described earlier in rejecting claim 1, but fails to teach forming a SiO₂ layer overlying the SiC substrate, at a growth rate of less than 10 Å per minute.

However, it would have been obvious to one with ordinary skill in the art at the time of the invention to judiciously adjust and control the nature of the inert gas and composition during the HT plasma deposition process through routine experimentation and optimization to achieve optimum benefits (see MPEP 2144.05) and it would not yield any unexpected results.

Note that the specification contains no disclosure of either the critical nature of the claimed processes or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen methods or upon another variable recited in a claim, the Applicant must show that the chosen methods or variables are critical (*Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir., 1990)). See also *In re Aller, Lacey and Hall* (10 USPQ 233 – 237).

7. Claims 10 – 14, 18, 24 – 30 and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Belyansky, US 2004/0129673 in view of Ouellet, US 2003/0059556.

Regarding claims 10 – 14, 18 and 36, Belyansky teaches most limitations as described earlier in rejecting claims 4 and 8, but fails to teach supplying an atmosphere including oxygen includes supplying SiH₄, N₂ O, and N₂ at a ratio of 10 – 25 : 100 : 50.

Ouellet teaches a PECVD method of depositing SiO₂ in an atmosphere including He and oxygen includes supplying SiH₄, N₂ O, and N₂ for the benefit of forming an oxide film with well controlled silicon oxide stoichiometry in paragraph 9.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Belyansky and supplying an atmosphere including oxygen includes supplying SiH_4 , N_2O , and N_2 for the benefit of forming an oxide film with well controlled silicon oxide stoichiometry in paragraph 9.

It would have been obvious to one with ordinary skill in the art at the time of the invention to modify Belyansky and supply the SiH_4 , N_2O , and N_2 at ratios by judiciously adjusting and controlling their ratios during the plasma oxidation of the SiC substrate through routine experimentation and optimization to achieve optimum benefits by forming an oxide film with well controlled silicon oxide stoichiometry as taught by Ouellet in paragraph 9 (see MPEP 2144.05).

Note that the specification contains no disclosure of either the critical nature of the claimed processes or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen methods or upon another variable recited in a claim, the Applicant must show that the chosen methods or variables are critical (*Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir., 1990)). See also *In re Aller, Lacey and Hall* (10 USPQ 233 – 237).

Regarding claims 24 – 30, Belyansky teaches limitations of these claims as have been described earlier in rejecting claims 10 – 14 and 19 – 23.

8. Claims 15 – 17 and 35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Belyansky, US 2004/0129673 in view of Chen, US 4,888,820.

Belyansky fails to teach the quality of the oxide films in terms of BTS, breakdown strength and leakage current density.

Chen teaches that these parameters are used to compare the qualities of silicon oxide films with that of the thermal oxide films as has been the standard dielectric material for silicon capacitors in column 1, lines 10 – 21.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Belyansky and control these oxide film qualities so that the quality of this film is comparable to the quality of the film formed by thermal oxidation since thermal oxide film has been the standard dielectric material for silicon capacitors as taught by Chen in column 1, lines 10 – 21 and the actual values for the plasma oxide can be controlled through routine experimentation and optimization to achieve optimum film quality in terms of dielectric property.

9. Claim 31 is rejected under 35 U.S.C. 103(a) as being unpatentable over Belyansky, US 2004/0129673 in view of Furukawa, US 5,135,885.

Belyansky teaches most limitations as described earlier in rejecting claims 1 – 3.

Belyansky fails to teach etching the SiO₂ layer, exposing a region of the SiC substrate, and, depositing a metal in the exposed region of SiC substrate to form a metal – semiconductor contact.

Furukawa teaches etching the plasma deposited SiO₂ layer on the SiC substrate, exposing a region of the SiC substrate, and, depositing a metal in the exposed region of SiC substrate to form a metal – semiconductor contact with reference to Figs. 1(d) and 1(E) in column 7, lines 35 – 45 for the benefit of making a SiC device that is useful for high temperature operation.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Belyansky and etch the plasma deposited SiO₂ layer on the SiC substrate, exposing a region of the SiC substrate, and, depositing a metal in the exposed region of SiC substrate to form a metal – semiconductor contact for the benefit of making a SiC device that is useful for high temperature operation as taught by Furukawa in column 7, lines 35 – 45.

Allowable Subject Matter

10. Claim 34 is allowed.

11. The following is an examiner's statement of reasons for allowance:

Claim 34 recites, inter alia, a method of forming silicon dioxide (SiO₂) on a silicon carbide (SiC) substrate, the method comprising the steps of providing a SiC substrate; supplying an atmosphere including less than 10% oxygen; performing a high-density plasma-based process and forming a silicon dioxide (SiO₂) layer overlying the SiC substrate. Belyansky fails to teach supplying an atmosphere including less than 10% oxygen. Additionally, the art of record does not disclose or anticipate the above limitation in combination with other claim elements nor would it be obvious to modify the art of record so as to form a device including the above limitation.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Response to Arguments

12. Applicant's arguments filed April 6, 2006 have been fully considered but they are not persuasive. The Applicant's argument regarding amended claim 1 (see last paragraph in page 16) alleging that Belyansky teaches "He as a non –preferred mixing gas because it does not support a rapid growth rate" is nonpersuasive. Belyansky observed (see paragraph 29) that light inert gas such as He does not result in a substantial increase of the oxidation rate. Nowhere does he say that use of He is detrimental to the oxidation process. Therefore, Belyansky anticipated the claim since he teaches all limitations of the claim. The Applicant also argues (see paragraph 2, page 17) that Belyansky is silent about the mechanism behind the formation of silicon oxide. This argument is found to be unpersuasive. Belyansky teaches creation of energetic atomic oxygen that causes formation of the oxide. In the case of SiC, the oxygen radicals will have to break the Si – C bond to form the oxide by binding the Si with the oxygen to form oxide and binding C to the oxygen to form CO or CO₂ depending on the amount of oxygen radicals present in the system especially when the Applicant's claimed process is similar to that of Belyansky.

Regarding claim 7, the applicant alleges (starting in paragraph 3, page 18) that it will not be obvious to removed the CO formed from the reaction. This is unpersuasive since all plasma deposition chambers are equipped with an evacuation system to maintain the flow rate and gas pressure during the deposition process.

The Examiner noted the affidavit made by Dr. Ono. Belyansky suggests using oxygen percentages from 10 – 95%. Although, Belyansky's invention is directed towards high growth rate (of the order of ~50 Å/min), the Applicant's claims are silent

about this feature when the use of He is recited in the claim. Applicant's claim 9 recites a deposition rate of $\sim 10 \text{ \AA/min}$ and this rate is not high according to Belyansky (see paragraph 29). Therefore, Belyansky's preference of using argon rather than He is not really a teaching away from the oxidation process but a mere suggestion that he did not observe high growth rate (of the order of $\sim 50 \text{ \AA/min}$) when used with his suggested oxygen concentration.

Regarding claims 10 – 14 and 24 – 30, the Applicant's argument with reference to Ono's affidavit is not persuasive because the Applicant is applying a piecemeal analysis. Both Ouellet and Belyansky teach a plasma process and Belyansky uses a normal CVD reactor. Therefore, Ouellet's process can also be utilized with Belyansky's apparatus. Since, Belyansky teaches HD plasma process, it is not necessary for the secondary reference to also duplicate and teach/suggest HDPECVD.

Regarding claims 15 – 17 and 35, the Applicant's argument is not persuasive for the following reason. Belyansky teaches a process of growing silicon dioxide by a method that is very similar to that of the Applicant's process. Therefore, it will be obvious to one with ordinary skill in the art that the grown oxide will also have characteristics similar to that of the Applicant.

Similarly, regarding claim 31, the Applicant's argument is not persuasive since Belyansky teaches the use of He as was mentioned earlier in the response to the arguments.

Conclusion

13. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

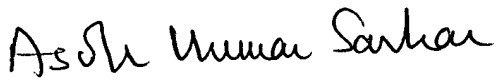
A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Asok K. Sarkar whose telephone number is 571 272 1970. The examiner can normally be reached on Monday - Friday (8 AM- 5 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, William B. Baumeister can be reached on 571 272 1722. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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15. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).


Asok K. Sarkar
May 2, 2006

Primary Examiner